Dr. Ted Maddess **Visual Sciences**

ted.maddess@anu.edu.au
http://cvs.anu.edu.au/maddess/
http://rsbs.anu.edu.au/rsbsweb/bru/

tel 61 (0)2 6125 4099
fax 61 (0)2 6125 3808

Honours/Ph.D. Projects Neuroscience/RSBS

I am working in the Visual Sciences Group at the RSBS that is part of a larger ANU organisation the Centre for Visual Sciences. My main research interests are in the area of dynamic, adaptive and nonlinear vision. Some of my recent research themes include adaptive eye movements, image motion processing, illusory brightness induction, texture discrimination, undersampling and some applied projects relating to glaucoma and multiple sclerosis monitoring and diagnosis. Techniques in the lab include eye movement monitoring, psychophysical, behavioural, and evoked potential methods. The evoked potential studies are mainly collaboration with Dr. Andrew James, also at RSBS. This work includes methods for recording responses to many simultaneously present visual, or other, stimuli. There is also scope for single or multiple neuron recording from vertebrate or invertebrate preparations.

(1) Evoked potential (EP) studies

Background: Dr. James and myself have developed some new visual stimuli that permit multiple visual stimuli to be presented at once. These new stimuli are biased towards stimulating neural gain control mechanisms, or permit specific interactions to be characterized.

(a) A study of sparseness

Questions: The idea here is to examine some novel stimuli where the polarity and temporal density of stimuli are manipulated to examine their effect on evoked potentials. The study is important because work so far suggests that these stimuli can be used to study dynamic gain control mechanisms. A variant allows binocular visual mechanisms to be investigated.

(b) Studies of visual neural diseases

Questions: Here we would apply the EP methods to either glaucoma, multiple sclerosis or reading dyslexia. The idea is to look at causes and methods for monitoring and detection.

(c) Studies of visual illusions

Questions: Here we would apply the EP methods to quantifying interactions between different parts of visual stimuli. Of particular interest is motion capture where moving stimuli presented in one part of the visual field cause other flickering stimuli to appear to move. Other illusions under investigation are the spatial frequency doubling illusion.

Methods: Standard EP methods are employed in conjunction with binocularly presented stimuli. The responses are estimated by nonlinear systems identification methods.

What you'll learn:

- Topical new EP methods
- Nonlinear systems identification
- Programming in a higher level language (Matlab)
- About neuro/ophthalmic disorders

(2) Psychophysical studies

Background: One area of interest is what certain visual illusions can tell us about visual processing. The illusions under study include illusory brightness and filling in, the apparent fineness effect, the spatial frequency doubling illusion. Other, texture discrimination and learning effects.

(d) Illusory brightness

Questions: We have shown that illusory brightness, as seen in the Craik-O'brien-Cornsweet (COC) effect, takes time to build up and is consistent with filling-in effects. Recent work as begun to look at long range interactions between different COC patterns presented simultaneously to see what limits or defines the rules of brightness propagation.

(e) Apparent Fineness

Questions: Certain patterns are seen to have a scale that is illusory. Our initial work has shown that cortical processing accounts for some of the effect. New work will examine what apparent fineness can tell us about cortical processing.

(f) Frequency Doubling

Questions: The FD effect is interesting because it tells us about retinal contrast gain control. We have used it to develop new tests for glaucoma that are currently being sold internationally and won the Australia Technology Prize in 1999. This work would involve either further studies on glaucoma and normal subjects, or aspects of how and why we see this illusion.

(g) Texture Discrimination

Questions: A certain class of textures is of particular interest here, so called iso-trigon textures. These textures are interesting because although different classes of these patterns look quite different to humans they are mathematically quite difficult to distinguish. It seems we must be using information about correlations between sets of 4 or more pixels to discriminate these patterns.Following our initial work one avenue to persue might be to look for so called perceptual learning effects with these patterns. Perceptual learning is where different parts of our visual field learn at different rates.

(h) Second Order Motion

Questions: The human visual system may have several mechanisms for detecting image motion. This project looks at a case where one of these possible mechanisms appears to break down.

Methods: Visual psychophysical methods are employed. This involves the creation of animated video sequences and characterisation of subject responses by statistical methods.

What you'll learn:

- Topical new psychophysical methods
- Statistical methods
- Programming in a higher level language (Matlab)
- About neuro/ophthalmic disorders

(3) Eye movement studies

Background: Our work to date has shown that our ability to track moving targets changes depending upon what we have been watching for the last few seconds. Possible applications for sport, driving and work-place safety exist.

(i) Illusory brightness

Questions: The idea here is to conduct studies where the eyes are relatively free to move to investigate these adaptive effects under relatively natural conditions. A project with application to glaucoma is also possible.

What you'll learn:

- Infrared eye-tracking methods
- Statistical methods
- Programming in a higher level language (Matlab)

(4) Do what you like!

We always welcome proposals that are within the scope of the methods described above.